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PROPOSAL FOR DEVELOPMENT OF A REMEDIATION PLAN FOR THE FORMER LAX PROPERTY

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CANVIRO CONSULTANTS

Project KI339.33

PROPOSAL FOR
DEVELOPMENT OF A REMEDIATION PLAN
FOR THE FORMER LAX PROPERTY

Prepared for:

Booth Aquatic Research Group Inc.

By:

CANVIRO CONSULTANTS

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1.0 BACKGROUND AND OBJECTIVES

The history of the former Lax Property has been summarized in previous study reports by BAR Group Inc. and Trow Ltd.

The relevant history is summarized briefly as follows:

1968-1984 - The property was built by the Lax brothers starting in 1968 with clean fill and non-toxic industrial wastes. (It has since been discovered that some wastes now defined as hazardous were also disposed in isolated pockets throughout the site.)

1984 - The property was acquired by the City of Hamilton.

1985-1986 - Several boreholes have been drilled on the property to determine the location and size of the hazardous waste pockets. Some boreholes have been fitted with groundwater sampling piezometers. Both private consultants and the Ministry of the Environment have been involved in the soil and groundwater sampling studies.

1986 - BAR Group Inc. submitted a report to the City of Hamilton entitled "Environmental Management of Industrial Wastes on the Former Lax Property". The recommendations included:

- surface industrial waste removal (either Philip Enterprises or Tricil Ltd.), and
- water quality monitoring.

1986-1987 - Philip Enterprises were hired by the City of Hamilton to remove surface industrial waste. However, costs were reviewed before completion since they were much higher than anticipated and the City has put a stop to the site work until estimates of quantities and costs for site remediation can be updated.

The overall objective of this project will be to develop a comprehensive Site Remediation Plan for the former Lax Property. Specific objectives will include:

i) Development of updated waste quantities still requiring removal.

ii) Development of procedures and criteria for managing the excavation operations (ie. so that only "hazardous" wastes are removed).

iii) Screening the disposal alternatives for the wastes requiring removal.

iv) Developing an operating plan and budget cost estimates for the required remediation work.

v) Preparing an engineering report that summarizes the study findings and presents the Recommended Remediation Plan, with schedule and cost estimates for consideration by the City of Hamilton.

2.0 SCOPE OF WORK

This project will be comprised of five separate tasks as described below:

Task 1: Mobilization Meeting

This will involve:

(a) Meeting with technical representatives from BAR Group Inc. and the City of Hamilton to finalize the work plan and schedule. It is probable that a meeting with MOE staff would be scheduled for the same day to obtain further input from them.

(b) Identifying City or MOE employees who will be able to assist in providing information about historic operations (ie. disposal areas, waste types, etc.) at the site.

(c) Arranging for City staff to do the surveying and chemical analyses.

Task 2: Review and Summarize Existing Data

This will include:

(a) Reviewing all existing soils and hydrogeological reports from previously conducted drilling programs (ie. several borehole logs are available) to develop soils profiles; define groundwater level and flow pattern; and establish where contamination was observed in the past.

(b) Establishing general surface geology; tying this into a geodetic benchmark; setting local benchmarks for future use and assigning all existing boreholes geodetic elevations. (It has been assumed that the City of Hamilton will do this work, with minimal direction from CANVIRO.)

(c) Reviewing old aerial photographs to trace the historical development and locations of waste disposal areas.

(d) Summarizing all existing data on a new site plan (and cross-sectional diagrams of the site, where possible).

Results of Task 2 will be summarized in a brief progress report identifying the most appropriate locations and number of additional test pits required in Task 3.

Task 3: Surface Investigation Program

An investigation program, consisting of shallow test pits, is proposed to define the extent and nature of contamination at or near the surface of the site.

The objective of the test pit program is to further define the extent and type of contamination at the site with particular emphasis on delineating specific pockets of contamination that exist at or near the surface of the site.

Prior to beginning work on the site, a Site Safety Plan will be developed for approval by our Director of Corporate Health and Safety to ensure the safety of CANVIRO, BAR and City of Hamilton personnel during the project.

It is expected that 15 to 20 test pits can be installed in the time allotted. These will be installed at locations selected as part of Task 2 in conjunction with City personnel. The test pit program will include the following aspects:

(a) Logging the depth of fill and soil profiles at each test pit.

(b) Collecting and analyzing soil samples at several test pits for contaminants of concern (ie. metals, phenols, pH, odour and visual characteristics will be used as contaminant indicators). Allowance has been made for collecting up to 15 soil samples for submission to the City of Hamilton for analyses.

(c) Performing leaching tests on selected samples (up to 5 samples).

(d) Developing an updated site plan showing the locations and size of identified pockets of industrial wastes.

Task 4: Determine Removal Quantities and Disposal Costs

By comparing the results of the sampling work done in Task 3 to MOE hazardous waste classification criteria, the quantities of wastes on the site that require removal will be determined.

Once the waste classification and quantification is completed, the various disposal alternatives will be assessed, and updated cost estimates will be obtained for the acceptable alternatives.

Because the disposal cost will be very dependent on the quantity and classification of wastes being removed, emphasis will be placed during this task in developing an operating plan that will more efficiently classify wastes during excavation. This plan will be developed in conjunction with the City, MOE and potential waste receivers. It is important that relatively uncomplicated criteria be developed to allow the site engineer to readily classify the wastes requiring removal as the excavation is proceeding (only hazardous wastes should be removed). Classification criteria could include: i) visual characteristics similar to wastes failing the leach tests in Task 3, and ii) on-site analyses (pH, conductivity or Hach kit metals).

Task 5: Preparation of a Remediation Plan Report

The report on the project will include summaries of the site investigation work (ie. test pit logs, chemical analyses, leach test results, waste locations and quantities).

The operating plan for waste removal, the disposal alternatives screening, selection and cost estimates will be presented.

The recommended Remediation Plan for the site, together with schedule and cost of implementation, will make up the final section of the report.

It should be noted that at this time, it has been assumed from previous study results that the impacts of groundwater contamination at this site are considered to be minimal. Therefore, the scope of work planned in this project with regard to groundwater will be limited to recommendations for future groundwater monitoring as part of the Remediation Plan.

If more effort in regard to hydrogeologic investigations of the site is desired by the City, then it could be provided by CANVIRO.

3.0 PROJECT MANAGEMENT

3.1 Project Team

Figure 1 describes the overall team organization and the liaison structure with BAR Group Inc. and the City of Hamilton. The Project Manager will be Mr. Richard Rush, Manager of the Hazardous Waste Division of CANVIRO, who has been involved in all of the industrial waste site investigations undertaken by CANVIRO in the past five years.

CANVIRO will work closely with BAR and City personnel, to ensure that the work is done in a timely fashion, with minimal inconvenience to plant operations. Mr. Rush will be the primary contact with BAR personnel. Mr. Whiffin will also have contact with BAR personnel with regard to gaining site access and day-to-day operations.

3.2 Project Personnel

Brief qualifications of key CANVIRO staff, for the Lax Property project are provided below. Corporate qualifications for CANVIRO Consultants are presented in Chapter 5.

3.2.1 CANVIRO Personnel

Project Manager - R.J. Rush, M.A.Sc., P.Eng.

As previously stated, the principal responsibilities of the Project Manager will include overall coordination of the project, direction of the specialists and liaison with BAR Group Inc. and the City of Hamilton. Mr. Richard Rush will serve as Project Manager for the proposed study and will also provide technical input to all phases of the project. He will coordinate inputs to the final report and also edit all report sections.

His involvement as Project Manager on the Pottersburg Creek watershed remediation work has demonstrated the necessary wide range of skills required to manage this site investigation and also any follow-up clean-up programs.

Mr. Rush is a graduate of Civil Engineering at the University of Waterloo where he specialized in water resources and wastewater treatment. He also has an M.A.Sc. Degree in Environmental Engineering from the University of British Columbia. Mr. Rush has over sixteen years of experience in the environmental field with numerous reports and publications dealing with treatment of wastewater, contaminated groundwater and hazardous wastes.

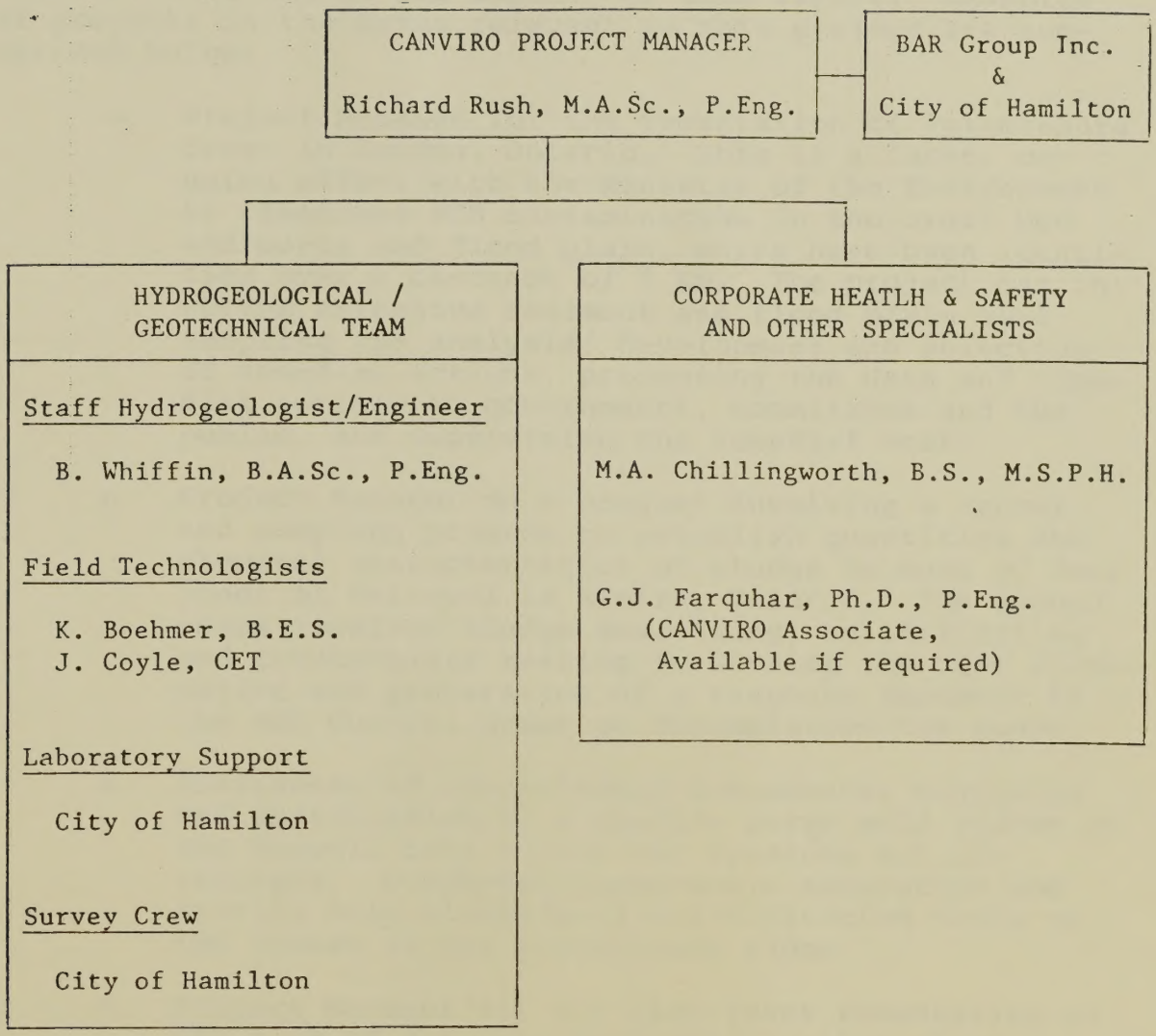


FIGURE 1 - PROJECT TEAM FOR THE LAX PROPERTY REMEDIATION PROJECT

Mr. Rush has a broad range of experience in environmental engineering, which will allow him to make technical contributions on all aspects of this report. Examples of projects in the areas relevant to this project are summarized below:

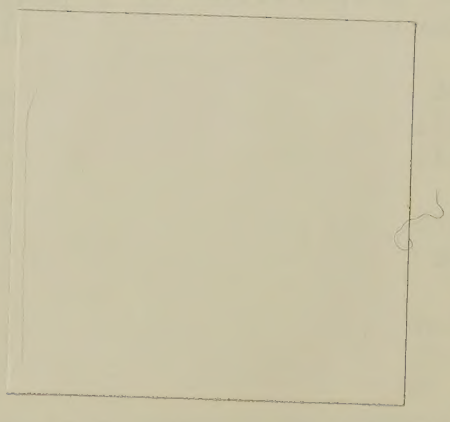
- Project Manager for the remediation of Pottersburg Creek in London, Ontario. This is a large, ongoing effort with the Ministry of the Environment to remediate PCB contamination in the creek bed sediments and flood plain, which have been identified over a distance of 7 km. The project has involved extensive sediment and flood plain soil sampling and analysis, development and selection of remedial actions, presenting the data and remedial actions to governments, committees and the public, and supervising the remedial work.

- Project Manager on a project involving a survey and sampling program to establish quantities and chemical characteristics of sludge in each of four ponds at Uniroyal in Elmira, Ontario. The second phase involved sludge dewatering, solidification and treatability testing to develop the best alternative and preparation of a response document to the MOE Control Order to decommission the ponds.

- Assessment of contaminated groundwater migration and installation of a shallow purge well system at the Forwell Site behind the Breslube oil rerefinery. Conducted large-scale excavation and on-site oily sludge/soil solidification tests on the source of the contaminant plume.

- Project Manager for the fast-track remediation of the site of a former coal gasification plant in Waterloo, Ontario. The current property owners, CN Real Estate, were constructing the new Waterloo City Centre on the site when the former plant works were discovered. CANVIRO coordinated the investigation and remediation activities at the site, including the removal of 20,000 cu.yd. of contaminated material in 40 days, and the treatment of 75,000 gallons of contaminated water on-site.

- Project Manager for various projects requiring development of groundwater quality criteria, involving literature review, discussions with regulatory authorities and treatability/clean-up assessment.



- Gloucester Site, Ottawa - 1,2-dichloroethane, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane and other volatiles, lindane, 2,4-D, PCBs (low levels), several non-priority pollutant organics (discussed below).
- Breslube Re-refinery Site - volatile organics, hydrocarbons.
- Grey Township Landfill Site - phenolics, chlorides.
- Robson Lang Tannery Site - chromium, phenols.
- Old Tannery Estates, Bracebridge - metals, phenols, hardness.
- Bestpipe Ltd., Kitchener - alkaline leachate from cement waste.
- Industrial Complex Fire, Kitchener - disposal of drummed oils, solvents and phosphating sludges.

o Project Manager for 3 projects relating to the Gloucester Site, Ottawa:

i) For Transport Canada
   - On-site treatability studies of air stripping for volatile organics removal; GAC for phenolics removal; lime treatment for iron and metals removal.
   - Review of health effects and treatability of various organics to establish site clean-up objectives, remedial measures screening.
   - Process design and costing of purge wells and treatment facility.

ii) For Environment Canada
   - On-site treatability studies of ozonation, chlorination and air stripping for organics removal (including PCBs at low levels).

iii) For Transport Canada
   - Sampling and analyses of local residential well waters and municipal water supply for volatile organics.

o Development of an environmental and technical information manual for PCB spills for Environment Canada. Responsibilities included:

- Developing models and graphical techniques to aid non-specialists in assessing the extent of PCB transport from spill sites.
- Writing manual sections related to PCB handling and storage procedures and spill response and contingency planning.

- Engineering study and environmental audit of former oil refinery properties in Petrolia and Enniskillen Township for the Ontario Ministry of the Environment. Responsibilities for this on-going project have included:
  - Reviewing the former crude oil refining operations and the more recent waste handling and disposal activities in the study area with regard to wastes produced and potential adverse environmental impacts.
  - Developing strategies for obtaining samples from in-ground storage tanks and assessing any existing surface and groundwater contamination.
  - Investigating resident concerns with regard to odours, surface runoff and general waste handling and disposal operations.

  This work has required considerable contact with local residents, current and former employees of the industries of concern, government agencies, subconsultants and the media.

- Management of a waste quantity survey for the Ontario Waste Management Corporation (OWMC).

- Development, costing and selection of treatment alternatives for remediating an aquifer contaminated with gasoline leakage from an underground storage tank, to existing government standards.

Sr. Project Hydrogeologist/Engineer
- B. Whiffin, P.Eng.

Mr. Whiffin is a Hydrogeological Engineer with CANVIRO, and will be leading the hydrogeological/geotechnical team on this project. He will be responsible for analyzing and reporting on the hydrogeological findings. He has earned a B.A.Sc. in Civil Engineering from the University of Waterloo, and is currently working toward an M.Eng. in Civil Engineering at the University of Ottawa. Mr. Whiffin's experience includes studies of groundwater flow and contaminant transport in a variety of subsurface environments. Among these environments were toxic waste sites, landfill sites, tailings, disposal areas, candidate nuclear waste sites, open pit mines, and groundwater systems in general. He has considerable experience in designing and conducting field investigation programs, data analysis and interpretation, using state-of-the-art predictive and analytical techniques. Mr. Whiffin has been involved on the fol-

lowing projects at CANVIRO and for a previous employer (INTERA Technologies Ltd., formerly GTC Ltd.) that are relevant to this proposal:

- Hydrogeologic investigation to assess the movement of dense, non-aqueous phase liquids from a former coal gasification plant on the Waterloo City Centre site.

- Waste management master plan studies for six candidate areas for development of landfill facilities.

- Hydrogeologic evaluations of a number (seven) of toxic and hazardous disposal sites in the vicinity of Niagara Falls, New York (ie. Love Canal, S-Area).

- Environmental compliance monitoring at the active CECOS hazardous waste disposal facility in Niagara Falls, New York.

- Field experiments to characterize the hydraulic and solute transport parameters in fractured rock in support of nuclear waste disposal.

- Selection of horizons for waste fluid injection and development of a groundwater monitoring methodology related to disposal of heavy oil processing effluents.

- Development of deep borehole fluid sampling equipment.

- Hydrogeologic assessment and application of remedial measures to a mine tailings disposal area near Timmins, Ontario.

- Field purge test studies to determine the desorption characteristics of volatile organic contaminants.

- Hydrogeologic evaluation of the effects of open-pit mine dewatering on the regional ground flow system in the Great Slave Lake Region.

- Evaluation of subsurface hydrogeologic testing techniques and documentation of measured hydrogeologic parameters in fractured crystalline rock environments.

- o Analysis of hydrogeologic field data as part of a hydrogeological/environmental assessment of gas plant decommissioning plans (2) operated by Gulf Canada.

- o Field investigation, landfill design and preparation of documentation or ministerial approval for a privately operated domestic waste landfill.

- o Evaluation of state-of-the-art techniques of vertical barrier wall construction for pollutant containment or migration control at waste disposal sites.

Field Technologists - K. Boehmer, B.E.S.
- J. Coyle, CET

Mr. Boehmer is a Field Technologist for CANVIRO, and will assist Mr. Whiffin during the test pit digging and field sampling. He has a B.E.S. in Environmental Studies from the University of Waterloo, and his project experience includes a number of hazardous waste sampling efforts. Mr. Boehmer was involved in the excavation, transportation and containment of PCB contaminated soil for the Pottersburg Creek remediation project. He was also involved in the coal tar remediation work for the Waterloo City Centre, and the environmental audit work for the Petrolia area. He previously performed field, laboratory and computer analyses for hazardous landfill sites, at the Canada Centre for Inland Waters.

Mr. Coyle has sampling experience at a variety of sites, and will assist Mr. Boehmer with the field work as required.

3.2.2 Specialists

Corporate Health and Safety Specialist
- M.A. Chillingworth, B.S., M.S.P.H.

Ms. Chillingworth is CH2M HILL's Corporate Health and Safety Director, and in this role she will review the site safety plan developed by CANVIRO for the Hart Chemical plant site study. Ms. Chillingworth has an M.S.P.H. in Environmental Science and Engineering, and a B.S. in Biology. Ms. Chillingworth has prepared more than 100 site safety plans. For CH2M HILL's Superfund work with the U.S. EPA, Ms. Chillingworth coordinates field visits, investigations and remedial measures at over 120 hazardous waste

sites, involving a staff of more than 200 CH2M HILL personnel and more than 20 subcontractor firms. She has coordinated and instructed more than thirteen 5-day hazardous waste site investigation training courses, and has prepared several chapters for the U.S. EPA Remedial Investigations Guidance Document.

Waste Site Specialist
- G.J. Farquhar, Ph.D., P.Eng.

Dr. Farquhar has had extensive experience in solid and hazardous waste management, soil and groundwater contamination from waste disposal, and with the behaviour of chemicals in soil. On this project, he will review the final report and be available for consultation if necessary.

Dr. Farquhar has a Ph.D. and M.A.Sc. Degree in Sanitary Engineering and is a recognized authority in the behaviour, monitoring and control of contaminants in soil and sediments. He is presently a Professor of Civil Engineering at the University of Waterloo, Waterloo, Ontario. Dr. Farquhar has authored over 70 scientific papers, reports and books, many of which are relevant to this project:

- "PCB Interactions with Soil", Environment Canada.
- "Extractions and Resolubilization of PCBs from Soil", for Environment Canada.
- "Field Studies of Groundwater Contamination", for Ontario Ministry of Health.
- "Liquid Industrial Waste Attenuation in Soil", for Environment Canada.
- "Monitoring Contaminant Migration from a Landfill", for Canada/Ontario Agreement Committee.
- "Technical Assistance Manuals for Spills of 50 Hazardous Chemicals", for Environment Canada.
- "Assessing the Behaviour of Immiscible Liquids in Soil", for the MOE.

4.0 COST ESTIMATE AND SCHEDULE

4.1 Cost Estimate

A cost estimate for the project is presented below based on the outlined scope of work.

Manpower

Personnel	Title	Rate (8hr day)	Man-Days	Total Days
R. Rush	Project Manager	$680	3	$ 2,040
B. Whiffin	Project Hydrogeologist	415	11	4,565
K. Boehmer	Field Technologist	220	6	1,320
J. Coyle	Field Technologist	220	6	1,320
G. Christie	Draftsman	325	2	650
V. Yandt	Typist	200	2	400
M. Chillingworth	Hygienist	500	0.5	250
G. Farquhar	Specialist	500	0.5	250
		Total Manpower Cost		$10,795

Direct Expenses

1)	Backhoe 2-3 days of backhoe time (City of Hamilton)	$(1,800)*
2)	Sampling & Safety Equipment - bottles, coolers, gas monitoring meters, protective clothing, etc.	700
3)	Miscellaneous - Shipping, mileage, meals, communication, copying, photo supplies, etc.	1,200
4)	Chemical Analysis - up to 30 soil and leachate analyses for metals, phenols & pH (to be provided by City of Hamilton)	(3,450)
5)	Surveying - estimated 5 days for a City of Hamilton survey crew	(5,525)
	Total Direct Expenses	$ 1,900
	TOTAL PHASE 1 PROJECT COST	$12,695

* It is assumed that backhoe, surveying and chemical analyses support could be provided by the City of Hamilton. Costs shown in brackets are the estimated costs for CANVIRO to provide these services if preferred by the City.

4.2 Schedule

We would be prepared to begin work on Task 1 immediately upon receiving authorization to proceed. It is suggested that Tasks 2 and 3 be conducted during dry weather conditions (ie. July or August). The final study report would be submitted by August 30, 1987 if authorization is received by July 1.

5.0 CORPORATE EXPERIENCE OF CANVIRO/CH2M HILL

CANVIRO Consultants, A Division of CH2M HILL Engineering Ltd. is an environmental engineering firm specializing in the development and application of water, wastewater, sludge and hazardous waste management technology. Since 1977, CANVIRO has grown to a staff of more than 60 with offices in Waterloo and Mississauga. CANVIRO's staff is comprised of designated environmental and consulting engineers, professional engineers, chemists, technologists, technicians, computer programmers and support personnel.

The firm specializes in waste treatability and design studies, often involving unique industrial waste disposal problems which require innovative treatment or remedial measures. Corporate experience encompasses hazardous waste and groundwater studies, industrial and municipal wastewater treatment and sludge management, state-of-the-art technical assessment and applied research and development for new technologies.

In addition to the main laboratory in Kitchener, CANVIRO has a mobile laboratory equipped to perform most routine environmental analyses. This mobile lab was used during the groundwater decontamination studies at the Gloucester landfill site, which is described below. CANVIRO also has capabilities for toxic organics sampling, extraction and analysis by gas chromatography (Varian 3700 GC with capillary columns and EC and FI detectors).

CANVIRO Consultants have extensive experience in the sampling, characterization, handling, treatment and disposal of numerous types of hazardous wastes, including radioactive materials, cyanides, arsenic, PCBs and unidentified drummed wastes. The company is a leader in the development of procedures and methodologies that will permit accurate, reproducible measurements of trace organics in heterogenous materials such as industrial sludges and contaminated soils.

Through our recent merger with CH2M HILL Engineering Ltd., we now provide full engineering services and have direct access to the expertise of over 2,500 CH2M HILL employees in 40 offices in North America and abroad, many of whom are directly involved in hazardous waste management.

CH2M HILL has considerable experience in the area of toxic and hazardous waste services. The firm's experience includes permitting, design, remedial actions, public relations support, regulatory and policy assistance, and construction management. Much of this experience has been

gained as a primary contractor to the U.S. Environmental Protection Agency on the REM/FIT contract under "SuperFund". Under this contract, CH2M HILL has responsibility for Superfund remedial actions in the entire western United States. Equally important is the hazardous waste consulting work CH2M HILL has conducted for numerous private clients, both large and small, throughout North America.

Summaries of selected CANVIRO projects relevant to the proposed Environmental Assessment at the Guelph Site of Hart Chemical Limited are presented below:

A. Hazardous Waste Studies/Site Remediation

1. Evaluation of Lagoon Sludge Disposal Options

- Uniroyal Limited, Chemical Division, Elmira, Ontario

As part of a Ministry of the Environment Control Order, Uniroyal was required to replace existing effluent retention ponds with new above-ground engineered tanks. These ponds contained an estimated 1.6 million gallons of sludge which has accumulated over several years of use. CANVIRO was retained to develop an environmentally acceptable and cost-effective disposal method for the sludge.

The first phase of the project involved a survey and sampling program to establish quantities and chemical characteristics of sludge in each of four ponds (total of 12,600 m^2 of surface area).

The second phase, which will be carried out in 1987, will involve sludge dewatering and treatability testing to develop the best disposal alternative.

2. Waterloo City Centre Site - CN Real Estate

During construction of an office building in the City of Waterloo, coal tar residue was discovered in two large tanks. Upon learning that the property was the site of a former coal gasification plant, the owner, CN Real Estate, engaged CANVIRO to coordinate site investigations and remediation activities which included:

- o Investigating historical background
- o Taking immediate action to remove and control the source materials

- o Carrying out a hydrogeological assessment to determine the extent of contamination which threatened five municipal water supply wells nearby
- o Designing and implementing the most cost-effective remedial measures
- o Conducting environmental monitoring after remediation

The project involved environmental monitoring, "fast tracking" to enable building construction to remain on schedule, and extensive health and safety protocols to protect the workers and the public. Under the supervision of CANVIRO, over 20,000 cubic yards of contaminated material were removed within 40 days, 25,000 gallons of contaminated water were treated on-site, and plans were developed to conduct a full site investigation to determine the extent of subsurface contamination. Work is continuing on this project.

3. Remediation of PCB Contamination of the Pottersburg Creek Watershed, London

CANVIRO was selected as the prime consultant by the Ministry of the Environment to conduct the clean-up of PCB contaminated sediment and flood plain soils in the Pottersburg Creek watershed in London. The project involves:

- o Sampling and analysis to delineate the extent of contamination
- o Site surveying and mapping
- o Screening of remediation alternatives
- o Design and costing of the best alternative
- o Project management and supervision during the actual clean-up

The clean-up began in July 1985 and involves:

- o Excavation and storage of highly contaminated (>20 ppm PCBs) soils and sediments
- o surface sealing/covering with clean topsoil in areas of low contamination (1 to 20 ppm PCBs)
- o Treatment of all equipment washwaters by filtration and carbon adsorption

The project schedule calls for remediation to be completed by the end of 1987. This will be followed by a confirmation sampling program to verify that clean-up has been completed according to the design specifications.

4. Former Oil Refinery Properties, Petrolia, Ontario

An environmental audit and report is currently being prepared by CANVIRO for the Ontario Ministry of the Environment for the former oil refinery properties in the Town of Petrolia and Enniskillen Township. The work includes:

- o A review of former operations at all properties associated with crude oil refining and related activities in terms of type of wastes produced and potential adverse environmental impacts
- o An assessment of groundwater quality, surface water quality and air quality as it may be affected by past and present activities at the properties
- o Recommendations for remedial actions to address the environmental problems identified

This work has required the development of innovative techniques to obtain oil, water and sludge samples from wood stave-lined in-ground storage tanks that are up to 70 feet deep. Also, drilling and sampling programs have been developed for assessing any soil, air, surface water, and groundwater contamination.

5. Forwell Site, Breslau (Breslube Re-refinery)

CANVIRO has conducted two separate projects relating to the Forwell Site, situated behind the Breslube oil re-refinery near Breslau, Ontario.

i) For MOE/Region of Waterloo, 1983
   - Large-scale excavation and on-site sludge/soil solidification tests on the source.
   - Delineation of contaminant plume.
   - Installation of shallow aquifer purge well system.

ii) For Region of Waterloo, 1984
   - Further characterization of contamination in the upper and lower aquifers.
   - Purge well system operational tests.

6. Gloucester Landfill Waste Site: Problem Definition and Remedial Alternatives

- Transport Canada and Environment Canada

CANVIRO has been involved in three related projects to further delineate the problem and select the best remedial solution for the Gloucester site. Characterization and locations of the two leachate plumes were undertaken and treatment efficiency was investigated on-site, supported by CANVIRO's Mobile Environmental Laboratory. Treatment processes tested were lime precipitation (for metals), air stripping, granular activated carbon, ozonation and chlorination for organics removal.

The recommended best alternative for the Gloucester site included:

- o Provision of alternate water supply to local residents.
- o Excavate and dispose off-site, selected special wastes.
- o Purge well recovery of contaminated groundwater with on-site treatment (lime, air stripping, GAC).
- o Re-injection of treated water.

7. Treatment of Groundwater Contaminated by Gasoline Tank Leakage

Water and Earth Science Associates (WESA) was engaged by Gulf Canada to investigate and clean-up contaminated groundwater in the vicinity of a gas station in Eastern Ontario. WESA contracted CANVIRO to screen treatment alternatives based on preliminary hydrogeological and chemical data.

Phase 1 of this project was completed in December 1985. The most cost-effective alternative for complete treatment of this groundwater containing a mixture of volatile and non-volatile organics appeared to be Granular Activated Carbon. However, it was noted that depending on the Ministry of the Environment's requirements for some of the non-volatiles (particularly indene), air stripping may provide adequate treatment at approximately half the cost. It was recommended that Phase 2 include further discussions with the MOE and pilot-scale testing prior to selection and design of a full-scale system.

8. Disposal of Hazardous Sludges Following a Fire at an Industrial Plant

In the clean-up following a fire at an industrial plant in Kitchener, a number of drums were found in a destroyed electropainting operation. CANVIRO characterized the wastes, and determined that they were comprised primarily of phosphating sludges with some overlying oil and solvent. CANVIRO supervised the waste disposal efforts which included skimming of free floating oil by an oil reclamation company, disposal of the liquid portion of the wastes (primarily solvents) by a chemical waste company, and solidification of the residual solids. The solidified matrix underwent leaching tests to qualify for disposal in a local landfill.

9. Investigation of Nitrate Contamination in Groundwater

When nitrate contamination became evident and persisted in the water supply wells at a processing plant in Ontario, CANVIRO was engaged to delineate the extent of groundwater contamination in the area, identify the source and recommend corrective action. Groundwater monitoring wells were drilled and multi-level sampling piezometers were installed in each well. Based on the hydrogeologic data and chemical analyses obtained from this program, the source of the contamination was identified. Remediation alternatives are presently being considered by the company.

10. Monitoring at a Leather Tannery Waste Disposal Site

CANVIRO was retained by Robson Lang Leathers Limited of Kitchener to carry out preliminary site investigations at an abandoned waste disposal site at their Oshawa location. A groundwater and surface water monitoring program was developed, discussed with the Ministry of the Environment, and the surface water monitoring component was implemented as a first phase.

11. Hydrogeological Assessment of a Municipal Landfill Site

Grey Township was required by the Ontario Ministry of the Environment to provide a plan of development and operation for an existing landfill site. The Township retained CANVIRO to perform a hydrogeological assessment of the landfill's impact on the surrounding area. The location of an upper aquifer and the direction of groundwater flow were determined. A total of 15 test pits were excavated and three of these were fitted with piezometers. Deeper monitoring wells were also installed at the property boundary. Groundwater samples are now monitored for pollution indicators such as chloride, sulphate, ammonium, conductivity, soluble organic carbon, phenols and metals.

12. Study of Potential Groundwater Contamination by a Concrete Pipe Company

A large pipe manufacturing company in Kitchener was prohibited by the Region of Waterloo from depositing cement wastes from drying kilns into a gravel pit containing other construction wastes. Tests had shown that leachate from the uncured pipe was alkaline and a potential threat to groundwater. The pipe company contracted CANVIRO to determine quantities, types and leachability of the cured and uncured cement wastes. Results showed that these materials should fit the category of 'clean fill'. The Region agreed that controlled disposal in the gravel pit should be environmentally acceptable.

B. Technical Reviews of Hazardous Contaminants

1. Preparation of PCB EnviroTIPS Manual for Environment Canada

CANVIRO is currently completing a PCB EnviroTIPS (Technical Information for Problem Spills) Manual for the Environmental Emergencies Technology Division of Environment Canada. The objectives of the manual are to:

- Provide a reference document for those responsible for the action at spill sites to ensure a thorough knowledge of PCBs and possible actions one might take to mitigate damage

- Provide an extensive source of information for contingency planners
- Provide a source of information on and a review of current countermeasures for PCBs for developers of equipment and techniques to enable a review of current capability and possible directions for future development

The PCB EnviroTIPS manual contains information on the following topics:

- PCB physical-chemical data
- Production and trade names for PCBs, federal and provincial regulations on PCBs, PCB inventories in Canada, PCB equipment types
- PCB materials handling, containment systems for in-use equipment, design of PCB storage facilities, transportation procedures
- Rapid assessment models for assessing PCB environmental transport from spill sites
- Environmental and human health data
- PCB compatibility with equipment and materials of construction (e.g. pumps, valves, sealants) and other chemicals
- PCB spill and fire countermeasures
- Previous PCB spill experiences
- PCB analytical techniques

2. Review of Technical Study Results Supporting Development of Drinking Water Criteria for PCBs and Benzo(a)pyrene

This study for the MOE involved reviewing all current scientific literature related to health effects, toxicity, carcenogenicity, physical and chemical characteristics, treatability, occurrence and production data for PCBs and benzo(a)pyrene.

3. Literature Review of the Significance of Trace Substances in Petroleum Sludges Disposed of on Land

In a study conducted for PACE (The Petroleum Association for Conservation of the Canadian Environment), CANVIRO compiled a literature review to evaluate the fate of refinery sludges following land disposal. A computerized literature search

was coupled with personal communications with over fifty individuals and organizations in Canada, the United States and Europe. The final report, dealing with analytical methods for trace substances in sludges, levels of trace substances and fate of land-applied sludges, included 19 conclusions and 11 recommendations for further research.

4. Preparation of Information Dossiers for Hazardous Chemicals

Over thirty information dossiers were prepared for the Environmental Protection Service (Ontario Region) on hazardous organic chemicals that are manufactured or processed in Ontario. The information in the dossiers included physical and chemical data, fate, persistence, hazardous properties and manufacturing sectors where these chemicals may be utilized. CANVIRO made extensive use of in-house and nearby university reference libraries to compile the detailed information.

C. Waste Inventories

1. Inventory of Liquid and Special Wastes for 475 Industries in a Regional Municipality

In association with another consulting firm, CANVIRO conducted an inventory of liquid and special wastes in the Region of Waterloo for the Regional government and the Ministry of the Environment. A total of 475 industries in the area were contacted. The comprehensive inventory was used by the Regional government to determine the quantities of liquid and special wastes generated and treated within the Region so that future needs for treatment and disposal could be assessed.

2. Inventory of Liquid and Special Wastes from 1,000 Industries in Ontario

CANVIRO was retained by the Ontario Waste Management Corporation to interview 1,000 industries in the province to verify waste quantities estimated by previous studies, and to enable the OWMC to determine the size and types of processes for inclusion in their future waste management facility. CANVIRO subsequently interviewed an additional 200 industries to better assess waste quantities for selected industrial sectors and waste types.

D. Sampling, Analysis and Treatability Studies of Hazardous Contaminants

1. Assessment of PCBs in Municipal Wastewaters and Sludges

The levels of PCBs in 33 municipal wastewaters were determined, and the fate of PCBs in the effluent streams and sludges were determined at a large secondary treatment plant. PCB concentrations between 1 and 97 ppm (dry weight) were noted in digested sludge samples.

2. PCBs in Sludge Application Sites

In this study, soil samples at 10 sludge application sites in Ontario were collected and analyzed for PCBs and trace elements. Mean concentrations and variability within the site and between sites were determined.

3. Evaluation of Priority Pollutants (including PCBs) in Concentrated Flue Gas Desulphurization (FGD) Wastewater

PCBs and other Priority Pollutants were determined in the concentrated waste and evaporator overhead of evaporation systems treating the wastewater generated by flue gas desulphurization units at fossil-fuel fired electrical power generating stations.

4. Sediment Sampling Near a Pulp and Paper Mill Outfall

Samples of sediment were collected from the bed of a river downstream of a pulp and paper mill plant outfall. The physical/chemical and biological quality of the sediments were characterized to assess the impact of the mill discharge on the water and biota.

5. Sediment Sampling at Automotive Plant Wastewater Lagoon

The sediments in a wastewater lagoon at an automobile manufacturer were sampled to characterize and quantify the metals and trace organic compounds present in the bottom matter.

6. Sampling, Analysis and Prediction of Hazardous Contaminants in Municipal Sewer Systems

Two sewer catchment areas, one predominantly residential and the other completely industrial, were sampled by CANVIRO personnel to determine concentrations of hazardous organic and inorganic contaminants in the wastewater. Following data analyses, a computer model designated HAZPRED was developed to enable prediction of hazardous contaminant levels in the sewage, based on the characteristics of the catchment area, with a relatively high degree of precision.

7. Monitoring of Selected Trace Organics During Biological Wastewater Treatment

A study conducted in 1980 for the Ontario Ministry of the Environment, and Environmental Protection Service was the first effort in Ontario to monitor the fate of trace organic compounds in a conventional activated sludge plant. The fate of six compounds, primarily from a specialty chemicals firm, were examined in two pilot-scale activated sludge reactors and a pilot-scale anaerobic digester. Although the study primarily indicated the need for more sophisticated analytical methods, general conclusions regarding the fate of trace organics were made.

8. Fate and Mobility of Selected Trace Organics During Sludge Processing

CANVIRO evaluated the effect of three common sludge treatment processes (heat treatment, anaerobic digestion and anaerobic digestion plus polymer addition) on the fate and mobility of selected trace organics and metals in the sludge. Methods of extraction, clean-up and analysis were adapted and refined for sludge solids, liquids and leachates. Exceptionally good reproducibility of analytical results indicated that the proposed methods were satisfactory for analysis of trace organics in sludges.

9. Removal of Hazardous Contaminants in the Hamilton-Wentworth Pollution Control Plant

The Ontario Ministry of the Environment (MOE) funded a study by CANVIRO to monitor hazardous contaminants at the Hamilton WPCP in 1982. The

objective of the study was to provide an accurate estimate of the concentrations and annual loadings of hazardous contaminants entering and being discharged from the WPCP, in order to determine the present sewage treatment process efficiency and influencing hazardous contaminant removal. Parameters monitored included total PCBs, pesticides, PAHs and trace metals. Conventional parameters were also monitored for reference purposes.

10. Analysis of Steam Electric Generating Station Inventory Data

CANVIRO personnel reviewed and evaluated data acquired for 48 generating stations with emphasis on wastewater generation and characteristics, the operation of cooling water systems and ash handling systems and water treatment processes.

11. Treatment of Toxic Compounds in Coke Plant Wastewater by a Two-Stage Biological Fluidized Bed

CANVIRO personnel have investigated the removal of toxic organics from coke plant wastewater by biological fluidized bed technology for Dofasco Inc., Hamilton and the Wastewater Technology Centre, Burlington. All U.S. Environment Protection Agency priority pollutants plus additional semi-volatile base-neutral compounds were analyzed. The fluidized bed process was highly effective in reducing levels of trace organics and ammonia. Based on the results obtained, preliminary capital and operating costs of a biological fluidized bed system were developed for a full-scale by-product coke plant.

12. Evaluation of SO_2/Air Oxidation Process for Treatment of Cyanide-Containing Wastewaters

Gold mining and metal finishing operations are major sources of cyanide-bearing wastewaters, which are highly toxic to aquatic organisms. CANVIRO was retained by the Wastewater Technology Centre in Burlington to conduct laboratory-scale treatability studies to assess the technical and economical feasibility of a new process based on the oxidation of cyanide with sulphur dioxide and water in the presence of a copper catalyst. Removal efficiencies exceeding 99% of cyanide species and heavy metals were achievable during

treatment of gold mill effluents and metal finishing rinsewaters. The process appears to offer significant environmental, operational and economical advantages over conventional treatment technologies such as alkaline chlorination.

13. Treatment of Radium 226 Wastewater and Dewatering of Barium/Radium Sludges

CANVIRO conducted a characterization and treatability study for Rio Algom Mines and the Environmental Protection Service on dewatering of radioactive barium/radium sludges generated by uranium mine tailings treatment. Optional dewatering methods included mechanical thickening, centrifugation, vacuum and pressure filtration and natural freeze-thaw conditioning. Several methods for successfully dewatering the sludges were identified.

14. Treatability Studies of Ten Industrial Wastes

As part of the preliminary design of a mobile treatment system for liquid industrial wastes, Paragon Engineering Limited retained CANVIRO to conduct treatability tests on ten candidate wastes. The wastes included alkali sludges, emulsified oils, phosphating sludge, and pickling, cyanide and chromate solutions. Treatment sequences for each waste and an overall system process design were developed.

CH2M HILL, parent company to CANVIRO, is a large multi-disciplined consulting firm of engineers, planners, economists and scientists located in major centers through the United States. They have extensive experience in all aspects of hazardous waste management including:

- Assessment of waste disposal practices
- Process engineering
- Design and implementation of remedial measures.
- Site permitting
- Support services (hydrogeology, analytical chemistry, etc.)

CH2M HILL has been involved in many hazardous waste site clean-ups in America, including the notorious Love Canal site in Niagara Falls, N.Y. where they were responsible for implementing an impermeable liner and slurry

wall system to reduce migration of contaminated leachate from the site. CH2M HILL has also had extensive involvement in Times Beach, Missouri where streets and soils are contaminated with dioxin.

CH2M HILL has conducted or is in the process of undertaking a number of PCB remedial action and contaminant investigations. The following are selected projects that highlight CH2M HILL's experience relevant to this project.

York Oil Company
Moira, New York

The York Oil site is a 17 acre abandoned waste oil recycling facility which contains several steel storage tanks filled with PCB laden oils and the remains of three lagoons used to recovery waste oil. When in operation, these lagoons discharged into wetlands leading to a brook that discharged to the St. Lawrence Seaway.

Remedial actions at the site, performed under Section 311 of the Clean Water Act, included the removal of PCB laden material from the wetlands to three lagoons. Currently, two 10,000 gallon steel tanks containing PCB laden oil remain on-site. In addition, there is concern that the materials removed from the wetlands and stabilized with a concrete by-product material may be leaching into the groundwater.

CH2M HILL's responsibility in the York Oil project was to prepare a report for EPA including recommendations for immediate actions to be taken at the site and remedial actions for the final site closure.

Sinclair Refinery
Wellsville, New York

The Sinclair Refinery is an abandoned lubrication oil refinery facility located on the west bank of the Genesee River approximately one quarter mile upstream from the Wellsville water intake and water treatment plant. A fill area is located on the refinery site and is adjacent to the Genesee River. Periodically, high river levels have begun eroding the bank of the fill area, exposing various refinery by-products including 55 gallon drums of paraffin, residual clay, and hydrocarbons. As a result of the oil levels in the Genesee River during high flow periods, the Town of Wellsville is currently treating the drinking water with activated carbon.

Quanta Resources Site
Long Island City, New York

The City of New York Department of Environmental Protection retained CH2M HILL to provide supervisory and technical assistance in cleaning up an abandoned PCB-contaminated oil reclamation facility. Nearly 0.5 million gallons of PCB-contaminated oils and sludges, non-contaminated oils and sludges, and aqueous wastes have been successfully removed, transported from the site, and disposed of. CH2M HILL's responsibilities consisted of contractor evaluation and selection, contract and unit cost negotiations, overseeing a complete site inventory including taking split samples to their laboratory for analysis verification, and supervising the contractor's materials handling. They also verified material delivery to the disposal sites by performing a volume check and certification that the tanker seals were intact.

Field Brook Site (EPA Superfund)
Ashtabula, Ohio

CH2M HILL was retained to define the problem and prepare a remedial investigation for Field Brook, a tributary that meanders for approximately 4 miles, first through the largest and most diversified chemical industrial complex in the state of Ohio, and then through a residential area of Ashtabula before entering into the Ashtabula River. Both point sources and non-point sources have contaminated the sediments of Field Brook with a variety of toxic organics, toluene diamine, toluene diisocyanate, trichloroethylene, perchloroethylene, hexachlorobutadiene, hexachlorobenzene, PCB, heavy metals, mercury, and titanium. CH2M HILL is directing core sediment samples at 25 locations, surface water sampling at 25 locations, outfall sampling, and tissue analysis of fish and aquatic macro-invertebrates. These data will be used for the next phase of the project, which is a feasibility study to assist in determining the most cost-effective clean-up alternatives.

G & S Landfill (EPA Superfund)
Utica, Michigan

CH2M HILL is conducting a remedial investigation and feasibility study of this landfill, which from the latter 1950s to 1966 received millions of gallons of industrial waste liquids including oils, solvents, and process sludges. Liquid wastes were dumped in unlined pits and lagoons on the 40-acre site and PCBs have been measured in seeps and ponds at levels of 1,400 ppm. Other wastes were reported to be disposed of in 55-gallon drums and buried on-site. The site

was closed to industrial waste in 1967, but continued its municipal landfill operations until 1978. Remaining on-site today are areas of contaminated soil and unlocated buried waste drums. On the south and west margins of the site are several contaminated oil seeps and leachate ponds.

Activities to be undertaken by CH2M HILL include a hydrogeologic study, a groundwater and sampling analysis program by sampling 40 wells, a soil and sediment sampling program, a surface water program, and sampling of fish, aquatic macro-invertebrates, and mammals.

The extensive experience and network of contacts within CH2M HILL will significantly increase the depth of the CANVIRO Project Team.

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